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NOTES ON SOME PALEOZOIC ECHINODERMS

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The following notes are intended as a record of some fossil echinoderms recently added to the paleontological collections at the University. The first to be mentioned is a lot of five calyces belonging to a notable spiny-domed crinoid known as

1. *Batocrinus icosidactylus* Casseday.

Plate I, figs. 7-15.

The calyces are silicified and present quite clearly the normal features of the species. Some rather puzzling morphological details in one or two individuals are pointed out below. A general description of the species follows:

The width and height of the calyx are about equal; the height of the cup is less than one-half that of the dome and its surface from the top of the protruding basals to the arm-facets is concave.

Basals three, of equal size, forming a prominent ring, excavated below for the reception of the circular stem; lumen small. Radials five, wider than long, partly hidden by the basals, six-sided, distal edge concave; posteriorly the basals are normally separated by a heptagonal anal plate which is followed by three plates, one just over the anal, known as the second anal, and one on either side of the latter and interradial in position. Primibrachs two, the first quadrangular, the second pentangular and axillary; each is smaller than the radial. Secundibrachs two, larger than the primibrachs but similar in shape; tertibrachs three or four, quadrangular, arranged in rows separated by shallow depressions. Interbrachials two, or three, not connected with the tegmen, the first ten-sided and considerably larger than the second, the third, if present, very small.

Arms twenty, four to each ray, openings equally spaced and directed outward. Between each pair of arms and on a level with the arm openings are two oval respiratory pores and between the two arms of each pair are two more pores whose openings are a little higher than those just described; this makes forty respiratory pores in all. Length of arms unknown.

Dome plates thick and swollen, some of them elevated into

thornlike spines. Anal tube strong, central and studded at intervals with stout spines; total length unknown. In the arrangement of the tegminal spines one is located immediately above each pair of arm openings making a circle of ten spines at the same level around the lower part of the dome. The two spines over the four arms of each ray are joined at their base by a third spine situated just distal to them. This makes a trio of spines over each of the five rays. A single spine is located between the posterior triads and in line with the anal plates; this may be called the anal spine. Five to ten irregularly spaced spines are scattered over the dome above the triads and below the base of the anal tube.

As intimated above the specimens present certain individual features as follows: number 3794 conforms closely to the general description except that the anal plate is *hexagonal* and followed by *two* rather large plates in the next cycle, — an Actinocrinid rather than a Batocrinid character. Fine striae normal to the suture which separates the abnormal anal from the succeeding left-hand plate are the only decorations observed on this or on any of the five calyces. On this specimen the distal spines of the triads tend to be the longest on the calyx. Number 3794a is distinguished by the absence of an anal spine and in that the ten spines of the lower circle are all short, stumpy and blunt. In number 3795 the distal spine of the anterior triad is represented by a rounded swollen plate and the anal spine is short and inconspicuous; all the spines of this specimen are round and full at their bases but they contract notably at their midlengths and terminate, when complete, in sharp points. Number 3796 has nodose calyx plates, the anals and first interbrachials being conspicuously so. There are three interbrachial plates in the right anterior position, the distal one being very small. Anal spine well developed. Number 3797 has lost nearly half the plates of the dorsal cup but preserves about a centimeter of the stout anal tube on the anterior side of which and two or three millimeters above the top of the dome is a perforation close to one millimeter in diameter; it is surrounded by a smooth rim. The purpose of this orifice is not clear. It is surmised that it may have served as an anal opening in case the distal end of the tube had been closed by accident or otherwise; its anterior position complicates the case but does not make it insurmountable. At least certain Inadunate crinoids possessed of a ventral sac had openings at the base and midway the height of the tube. (Compare *Scytalocrinus, Culmicrinus* and others described by Frank Springer in "Unusual Forms of Fossil

Crinoids," Proc. U. S. Nat. Mus., vol. 67, 1926, pp. 65, 67, 74 and plates 17 and 18).

The specimens were secured by Mr. Ben H. Wilson of a local collector at Burlington and are said to have come from that vicinity. Wachsmuth and Springer (Crin. Cam. p. 368) state that the species comes from the Warsaw limestone at Spergen Hills, Indiana and Barren county, Kentucky. The specimens have the appearance of weathered Keokuk material. When obtained they were full of reddish clay which was carefully removed, washed and screened. In the residue are innumerable small arm ossicles and other crinoid parts, bits of bryozoa, and tiny embryonic brachiopods a fraction of a millimeter in diameter. The material in the screenings is insufficient to fix the horizon whence the crinoids came.

2. Tegmen of an Undetermined Crinoid.

Plate I, figs. 16, 17.

This interesting specimen consists of the dome or tegmen of some camerate crinoid, probably *Uperocrinus pyriformis* (Shumard). The tegmen is oval in shape, its short diameter being about an inch, its long diameter about one and one-fourth inches, and its height from the top of the arm openings to the base of the anal tube is close to one-half inch. A few of the dome plates bear short spines, the others are slightly tumid and all are irregularly polygonal; sutures distinct over most of the surface. Anal tube strong, centrally located but broken off.

The most significant feature of the specimen is the preservation and arrangement of the subtegminal grooves. These are bordered by stout ridges which are best developed peripherally. Four ridges, longer than the others, diminish gradually in prominence and die out before reaching the center; between them and near the periphery are numerous short and less prominent ridges which separate the intervening canals that arise at the arm openings. The convergence of the canals is well shown. On the anal side a broader and thicker ridge extends from the periphery inward; its flattened concave surface with elevated borders gradually widens distally and finally blends into the anal orifice; this feature evidently marks the course of the ascending gut.

Collected in the refuse of a quarry in the Burlington limestone, on Honey Creek, near Morning Sun, Iowa, by Dr. Louise Fillman. It bears University museum number 3798.

3. *Orophocrinus conicus* Wachsmuth and Springer
Plate I, figs. 1, 2.

Four specimens of this rare and interesting blastoid are the basis of this note. They are beautifully preserved and retain very well the delicate sculpturing on the plates. In shape they resemble an inverted cone about three-eighth of an inch long and about one-fourth inch in greatest width. Ambulacra five, petaloid, sunken in grooves between the deltoids; viewed from above the ambulacra resemble a tiny thick-armed starfish. Anal opening high up on the posterior deltoid. The five ambulacra radiate outward from the mouth and each is bordered by a narrow slit-like opening; there are twelve to fifteen side pieces to each half of the ambulacrum from which in life arose a row of pinnules.

Students desiring a complete description and an illustration of a specimen preserving the pinnules are referred to the Geological Survey of Illinois volume viii, page 201, plate XV, where the original description of specimens from LeGrand is published. Our four calyces were collected in the Kinderhook limestone at the type locality in LeGrand, Iowa, by Mr. M. A. Stainbrook. They are numbers 3209 to 3212 in the paleontological collection at the University.

4. *Orophocrinus legrandensis* n. s.
Plate I, figs. 3, 4.

This handsome blastoid is related to the last but in general shape and contour it is closer to *O. stelliformis* (Owen and Shumard) of the Burlington beds. The lower part of the basal cup is broken off otherwise the specimen is a fairly perfect calyx.

Calyx elongate balloon-shaped and stellate in cross-section. Periphery a little above midheight. Plates smooth except for delicate microscopic lines paralleling their edges. Sutures flush, their positions visible as discolorations in the calcite beneath the surface.

Basals three, apparently longer than wide, two of them five-sided and one, the right anterior, four-sided and smaller. Radials five, elongate-subquadrate in outline, their sides rounded and bulging gently outward at their midlengths; plate elevated centrally whence the surface slopes steeply to the sides but with a convex contour to the apex and with a concave profile below. A line drawn along the surface from the highest point on one radial across the oral pole to the highest point on an opposite radial describes a semicircle. Deltoids five, small, spearhead-shape, the

posterior one a little elevated and pierced by the anal orifice. Summit depressed centrally; ambulacra long, narrow, and turned rather abruptly downward; slits ten, linear and confined to the proximal half of each ambulacral area; median groove of ambulacrum faintly developed between the slits. The details of the distal half of each ambulacrum and of the side-plates and pinnule-sockets are obscured by a deposit of crystalline calcite.

Dimensions of holotype, number 3214, are: length (incomplete), 21.5 mm., width across periphery, 19.2 mm.; length of a radial, 15.6 mm., greatest width, 10.0 mm.

Remarks. — This is more elongate and the ambulacra are bent downward more abruptly than in *O. stelliformis,* moreover, the lips of the radial plates are more rounded and less protruding than in the latter. On the other hand *O. legrandensis* is more robust than *O. fusiforme* Waschmuth and Springer from LeGrand and in some ways it appears to possess characters intermediate between that species and *O. stelliformis.* Bather's paper (Jour. Geol., vol. 30, 1922, pp. 73-76) on "Growth Stages of the blastoid, *Orophocrinus stelliformis*" is of interest at this point.

Occurrence. — Holotype collected by Mr. Ben H. Wilson at the county stone quarry six miles southeast of Marshalltown. The specimen was found in a grayish encrinal limestone which was in place "high up in the quarry." The rock here belongs to the LeGrand formation at the top of the Kinderhook stage of the Mississippian. The echinoderm fauna of this formation has long been famous. Some of the species have Burlington affinities. However, the nearest mapped Burlington beds are forty miles away and the nearest outcrops of any extent are fully sixty miles to the southeast, (See Van Tuyl, Iowa Geol. Surv., vol. xxx, pp. 78-90, Plate I).

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PLATE I

All figures natural size unless otherwise noted.

Figs. 1, 2. *Orophocrinus conicus* Wachsmuth and Springer.

1. Right posterior interradial view showing the inverted cone shape, the nearly straight sides and a single round proximal stem segment.

2. Apical view showing outline, short ambulacra and the various perforations.

No. 3209, magnification times 2.5. Kinderhook; LeGrand.

Figs. 3, 4. *Orophocrinus legrandensis* Thomas.

3. Anterior view of the holotype. Note the long drooping ambulacra, the contour above and below the radial lip, and the elongate radials.

4. Apical view of same. The sharply down-turned ambulacra appear short when viewed apically.

No. 3214. Kinderhook; County quarry, near LeGrand.

Figs. 5, 6. *Orophocrinus stelliformis* (Owen and Shumard).

5. Side view of the valyx showing the broad parachute shape.

6. Apical view of same showing the concavi-stellate outline, the long ambulacra and the well marked slits and pores.

No. 3215, Burlington limestone, Burlington. Calvin Collection. Introduced for comparison with the two species from LeGrand.

Figs. 7-15. *Batocrinus icosidactylus* Casseday.

7, 8. Right anterior and basal views of No. 3796. Note the right anterior triad of spines, the nodose interbrachials and anals. The basal circlet of plates is lost; observe that the anal edge of the hexagonal opening is the shortest.

9. Anterior view of No. 3797. Note the perforation in the anal tube and the coarse tegminal spines.

10, 11. Posterior and basal views of No. 3797. Note that the anal plate is followed by two plates in the next cycle and compare figure 8. Observe also the rows of tertibrachs set off by grooves, the basal rim, the anal spine between the posterior triads, the arm openings and the respicatory pores.

12, 13. Basal and left anterior views of No. 3795. In this the spines are sharp and heavy and that they project in this and in No. 3796 well beyond the arm openings. The dome is high, the cup is short and the basal rim is prominent.

14, 15. Tegminal and posterior views of No. 3794a. Observe the blunt spines of the lower row, the absence of the anal spine and the thickness of the dome plates as seen in the break.

Figs. 16, 17. *Uperocrinus pyriformis* (Shumard).

16. Lateral view showing tegminal spines, the contour and the ventral half of the visible arm openings.

17. The same from within showing the converging canals and ridges; note the widening anal ridge blending into the anal orifice in upper part of the figure.

Burlington limestone, east of Morning Sun.

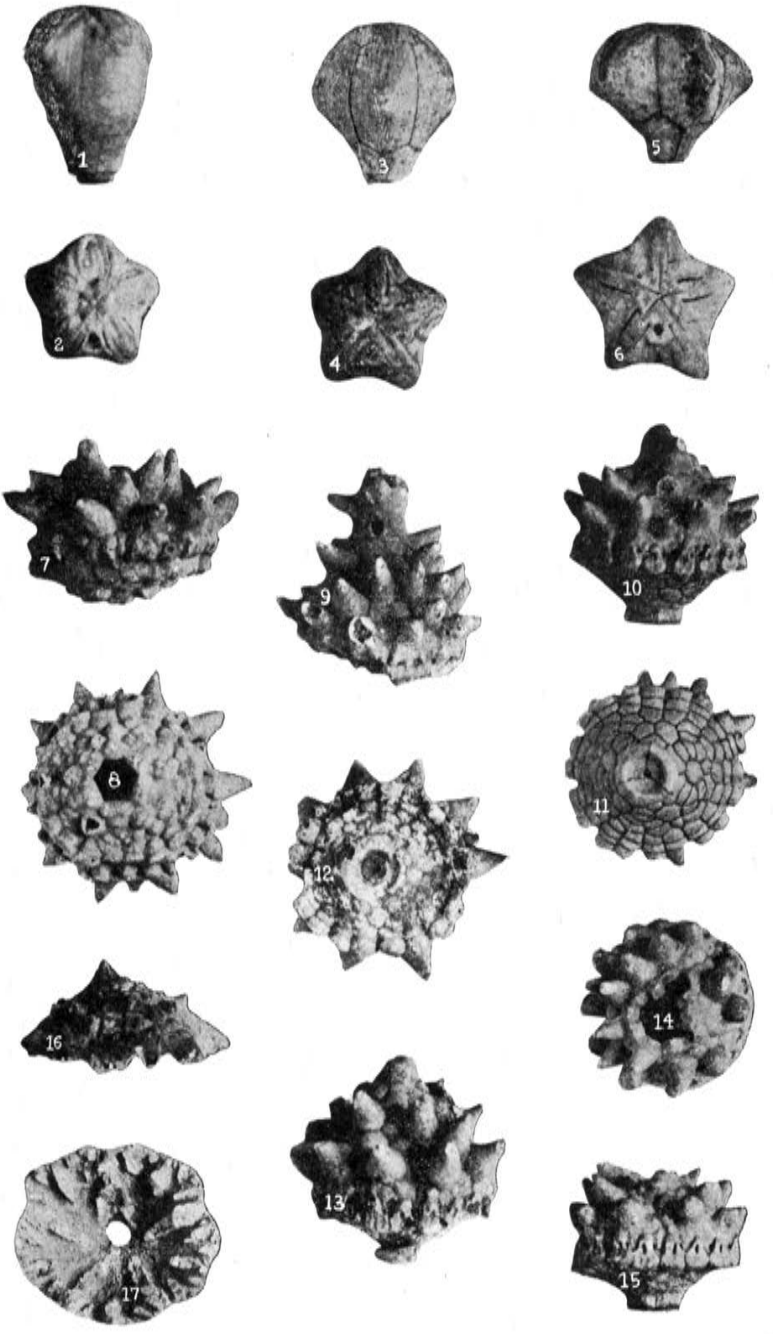

PLATE I